National Aeronautics and Space Administration

Directly Determined Linear Radii and Effective Temperatures of Exoplanet Host Stars

Kaspar von Braun (MSC/Caltech) & Gerard T. van Belle (ESO)

Project Objective

- Direct interferometric measurements of exoplanet host stars along with calculated effective temperatures can provide constraints in the characterization of the planetary system environment.
- Equivalent measurements of other nearby main-sequence stars enable statistical comparisons with respect to astrophysical parameters.

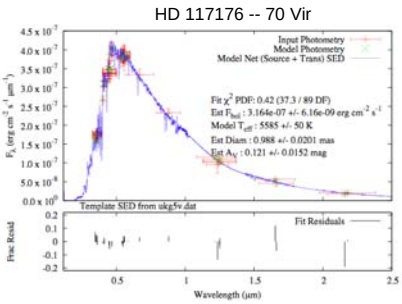
Motivation

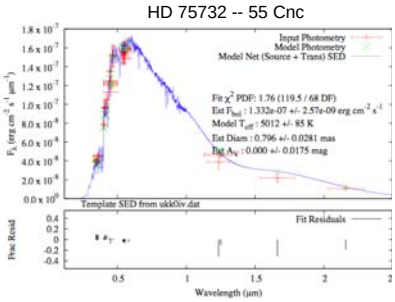
- Formation, evolution, environment (e.g., habitable zone) of exoplanets is dominated by properties of parent star.
- To provide constraints on the characterization of exoplanets, determination of astrophysical parameters of parent star is important.
- With knowledge of Hipparcos distance, angular diameter and bolometric flux (from literature) provide estimate of effective temperature.
- We used PTI to measure angular diameters and calculate effective temperatures for nine exoplanet host stars, as well as for a control group (~20 stars) of (non-exoplanet-bearing) main sequence stars.

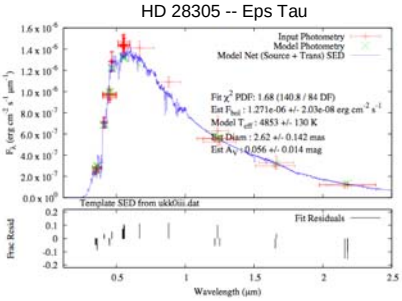
Project Description

Fig. 1: Observations were conducted at the Palomar Testbed Interferometer (PTI) in the *K* band (2.2 μm). Shown above are the beam combiner and delay lines.

Fig. 2: Examples of our SED fitting. The approach is as follows:







- Fit Pickles (1998) spectral template to literature photometry to obtain F_{bol}.
- Angular diameter is directly measured.
- Hipparcos distance and correction for limb darkening provides linear stellar radius.
- Calculate T_{eff} from Stefan-Boltzmann Law $T_{eff} \sim (F_{bol} / \theta^2)^{1/4}$.

Note:
- θ = angular diameter.
- Model T_{eff} and Est. Diam. are associated with template, not calculated values.

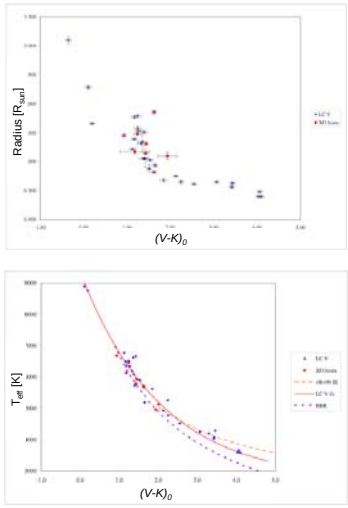


Fig. 3: Comparison between the nine exoplanet host stars and the main-sequence control group stars (resolvable by PTI). The upper panel shows radius, the lower one T_{eff}, both as a function of dereddened *V-K* color. The lower panel also shows fits to the control group stars (LC V), to the van Belle+ (1999) giants and a theoretical blackbody curve.

HD	Name	R[Rsun]	error	R[Rsun]	error	reference	diff[sigma]	Teff[K]	error	Teff[K]	error	reference	diff[sigma]
3651	A -	0.818	0.098	0.87		Pasinetti Fracassini+ 2001	0.5	5457	325	5221	44	Valenti & Fischer 2005	0.7
9826	Ups And	1.480	0.087	1.7	0.06	Fuhrmann+ 1998	2.1	6465	188	6213	44	Valenti & Fischer 2005	1.3
28305	Eps Tau	12.692	0.545	13.7	0.06	Mozurkewich+ 2003	1.8	4990	50	4901	20	Sato+ 2007	1.7
75732	55 Cnc	1.100	0.096	1.04	0.06	Lang 1980 (equations)	0.5	4952	216	5235	44	Valenti & Fischer 2005	1.3
95128	47 Uma	1.172	0.111	1.24	0.04	Fuhrmann+ 1998	0.6	6140	294	5882	44	Valenti & Fischer 2005	0.9
117176	70 Vir	1.858	0.124	1.87		Lang 1980 (equations)	0.1	5687	188	5545	44	Valenti & Fischer 2005	0.7
120136	Tau Boo	1.450	0.112	0.9		Pasinetti Fracassini+ 2001	4.9	6680	260	6387	44	Valenti & Fischer 2005	1.1
143761	Rho CrB	1.306	0.149	1.36	0.05	Fuhrmann+ 1998	0.3	5936	339	6387	44	Valenti & Fischer 2005	1.3
217014	51 Peg	1.141	0.133	1.17	0.04	Fuhrmann+ 1998	0.2	5800	338	5787	44	Valenti & Fischer 2005	0.0

Table 1: PTI results and literature values for stellar radii and temperatures. Shown in **blue** are our results, with literature values shown in **red** for comparison. **Diff[sigma]** indicates the difference between them in units of the standard deviation.

Summary & Results

- We present PTI results on the interferometrically measured physical radii of nine exoplanet host stars along with their associated T_{eff}, based on literature broadband photometry and spectral templates.
- Generally good agreement (< 2 σ) between our findings and literature values; exceptions: radii of Ups And & Tau Boo.
- As a function of dereddened *V-K*, we do not find any obvious difference in measured radius and T_{eff} between the exoplanet host stars and ~20 control group main-sequence stars.